

SUPERSATURATED SOLUTIONS: ROCK CANDY LAB

Purpose: To introduce crystal growth in order to demonstrate the properties of supersaturated solutions

Information: Solubility of substances improves with stirring (mechanical energy) and by heating (heat energy). You will find that the ***solvent*** dissolves only so much ***solute***. After a while, the excess solute precipitates to the bottom. When this happens, the liquid is a ***saturated solution***.

Solutes dissolve in larger quantities when placed into heated liquids (solvents) because the molecules of the heated liquids vibrate further apart. The spaces between the molecules become greater and more solid molecules (sugar) can fill these spaces. As the liquid cools down, the spaces between the molecules become smaller and the excess solids precipitate to the bottom. Heating solvents to dissolve additional solute. Once the solution cools, it now has more solute than it normally could have, and this is called a ***supersaturated solution***.

Once a solution becomes supersaturated, it wants to crystallize the excess solute. The solute will form crystals on any surface. In our case the surface is a string, and we are using a lifesaver candy as our “seed.” A seed is a starting point, a solid piece of sugar candy will mimic a sugar crystal, and start the chain reaction of crystallization. If the jar is left uncovered, crystals may even form on the dust that settles on top.

Equipment: 250 mL beaker, scale, sugar, water, a clean jar, string, stirring rod, and candy

Procedure:

1. Using the 250 mL beaker, measure 150 mL of water.
2. Measure out 450 g of Sugar using a plastic cup and spoon.
3. Adding 1 spoonful of sugar at a time, dissolve as much sugar as possible in the water. (you may add food coloring at this time if desired)
4. Once you have a saturated solution, place the beaker on a hotplate and allow the water to get hot, but do not bring to a boil
5. While waiting for the water, prepare a string by measuring approximately 15 cm and tying one to a Lifesaver.
6. Once the solution is hot, allow your instructor to bring it to your lab desk. Add one spoonful at a time of sugar until no more sugar can be dissolved. If the solution cools too much, reheat it on the hotplate.
7. Stir to help dissolve the sugar. When no more sugar dissolves and some remains in the bottom of the beaker, the solution is supersaturated - even if you do not see any solute in the bottom.
8. Tie the other end of the string to a popsicle stick so that the string hangs down into the jar and does not touch the bottom.
9. Pour the cooled solution into the jar.

10. Cover the jar with a piece of foil to keep the dirt out. Avoid bumping the liquid. As the liquid sits, the excess sugar molecules will come out of solution and climb the string.

Discussion:

1. What is the difference between an unsaturated, saturated and a supersaturated solution?
2. What was the solute in the lab? The solvent?
3. Why is it necessary to heat a solvent in order to make a supersaturated solution?
4. Describe a point in the lab where each of the following happened...
 - a. had an unsaturated solution
 - b. had a saturated solution
 - c. had a supersaturated solution
5. Why was it necessary to use a “seed candy”?
6. Sugar dissolves easily in water. Since “like dissolves like”, what does sugar’s solubility in water tell you about the properties of sugar molecules?
7. Besides increasing the temperature of the water, describe two ways you could get sugar to dissolve in water *faster*.
8. Talk with your group, and try to come up with one other method to create a supersaturated solution that does not involve heating. (How can you remove more solvent?)
9. You dissolved 450.0 g of sugar ($C_{12}H_{22}O_{11}$) in 150 mL of water. The density of water is 1.00 g/mL
 - a. calculate the molarity of the solution
 - b. calculate the molality of the solution

Conclusion:

A: Describe how you created a supersaturated solution and how you formed sugar crystals.

B: Describe The general shape of the crystals (were they round, jagged, smooth etc), and how does it compare to the sugar you started with. How successful were you at creating rock candy? Did you make a lot, a little?

C: Describe any problems you had with the crystals. Did any crystals form on places other than the string? Was any stuck to the jar? Explain how you think these problems could be avoided. If you had the perfect crystal, then explain why you think yours turned out so much better and explain how you think you can make even larger crystals.